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(54) Viscous fluid couplings

(57) A rotor 15 has a torque transmitting labyrinth 21. A partition 18 separates a reservoir 19 from a working chamber 20. A passage 25 and return holes 23, 24 with a valve plate 31 control the amount of fluid in the chamber 20. A bimetal spiral 29 provides a thermally responsive valve by rotating the plate 31 to open the return hole 23. A thermostat 46 in a water pump 38 of an engine cooling system moves the plate 31 axially to open also the return hole 24. Separate plates may be provided for association with the spiral 29 and with the thermostat 46. A cover 16 may carry an engine cooling fan.

F I G.1

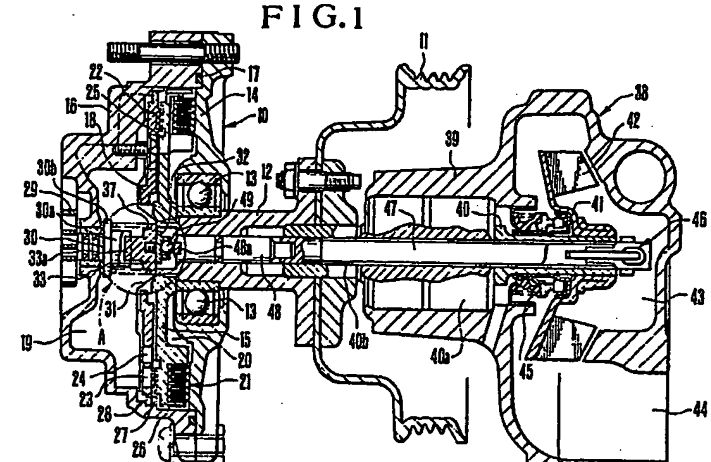

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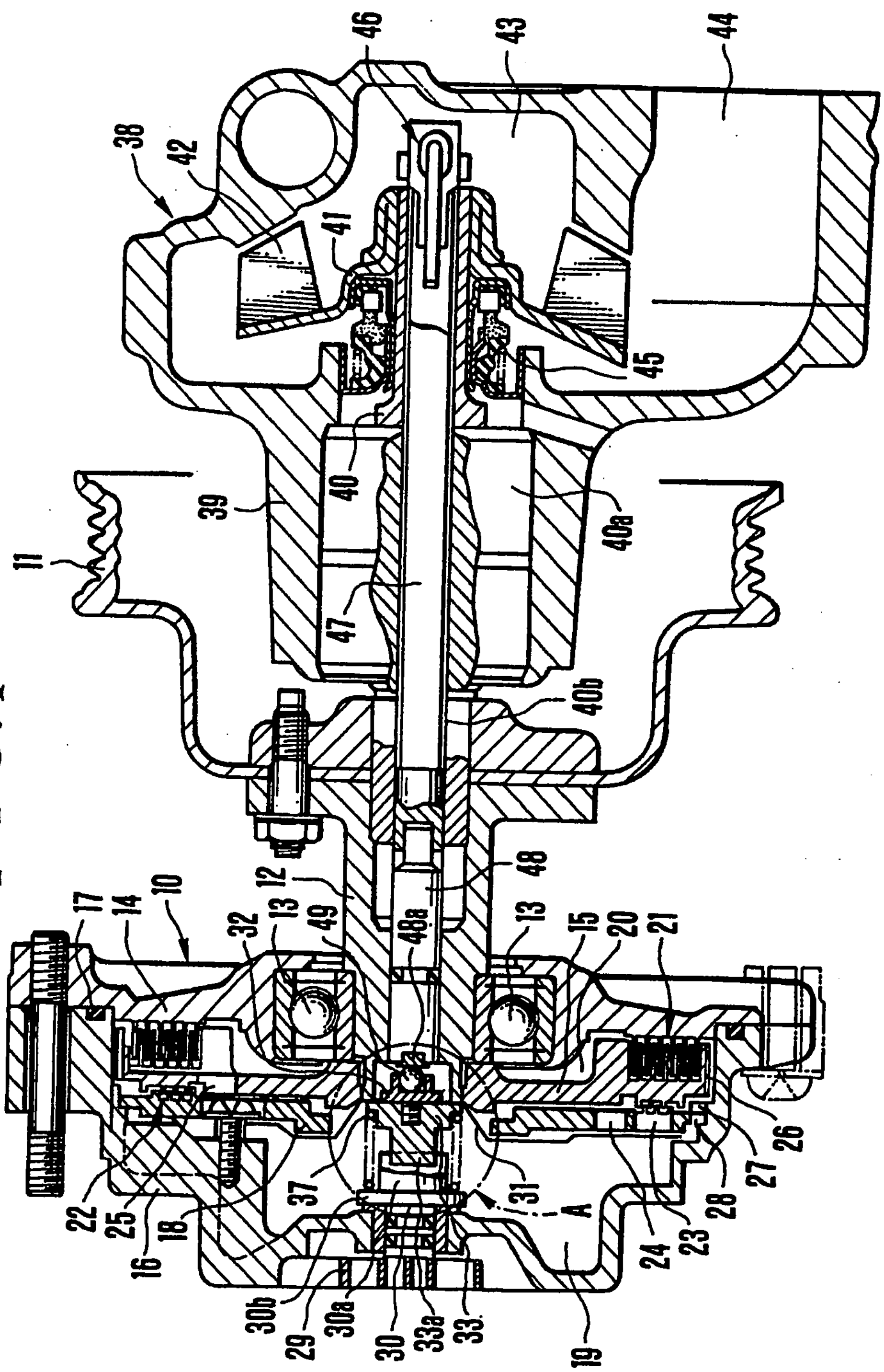
FIG.1



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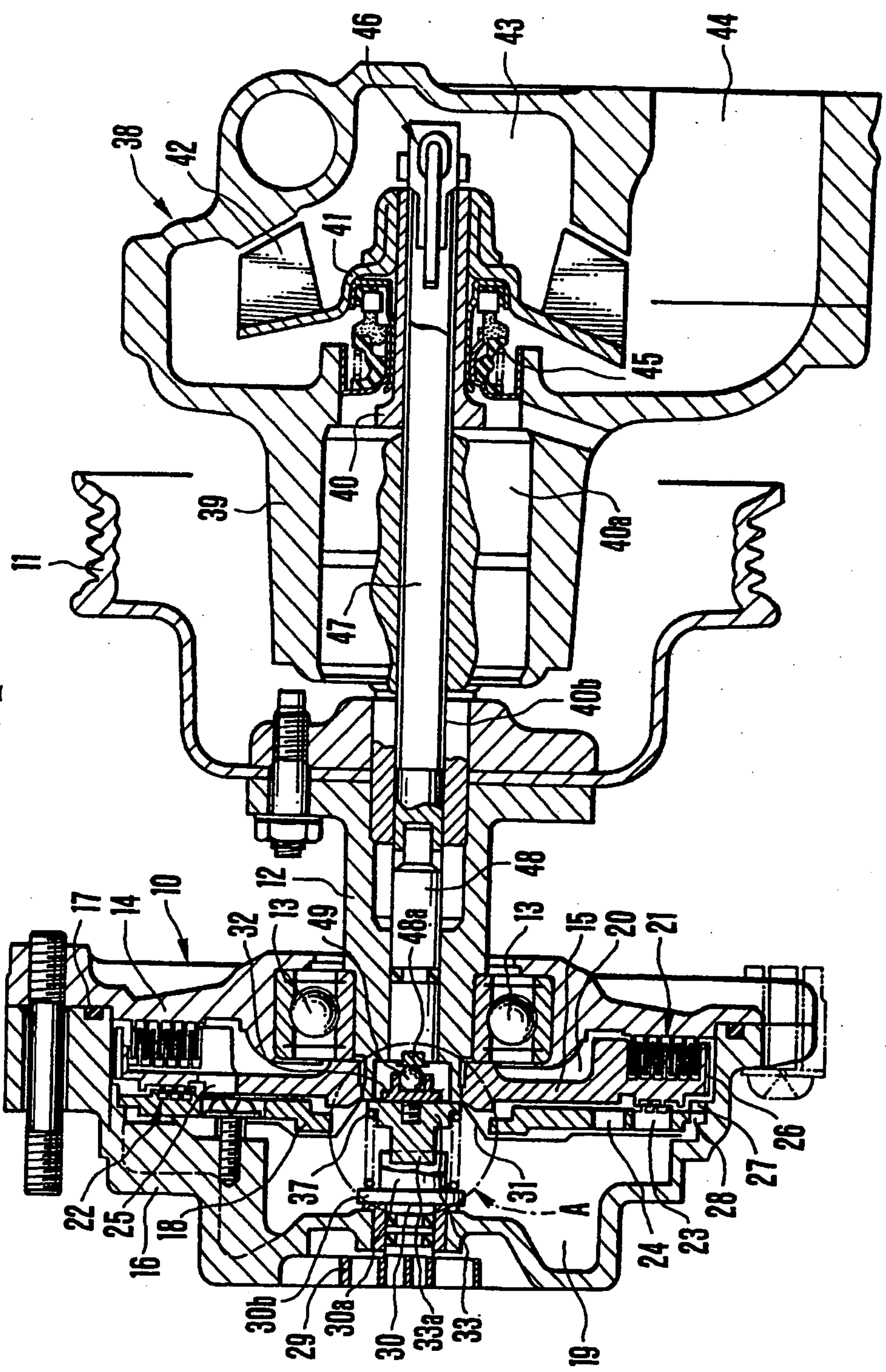

F I G. 1

FIG.4

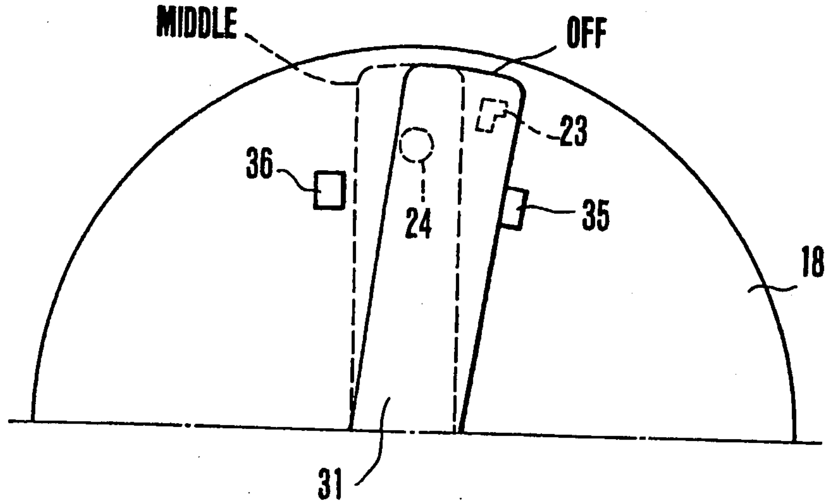

FIG.6

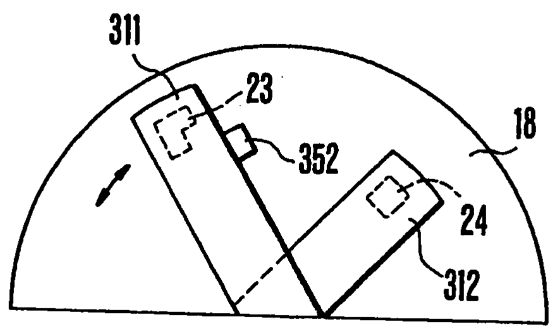

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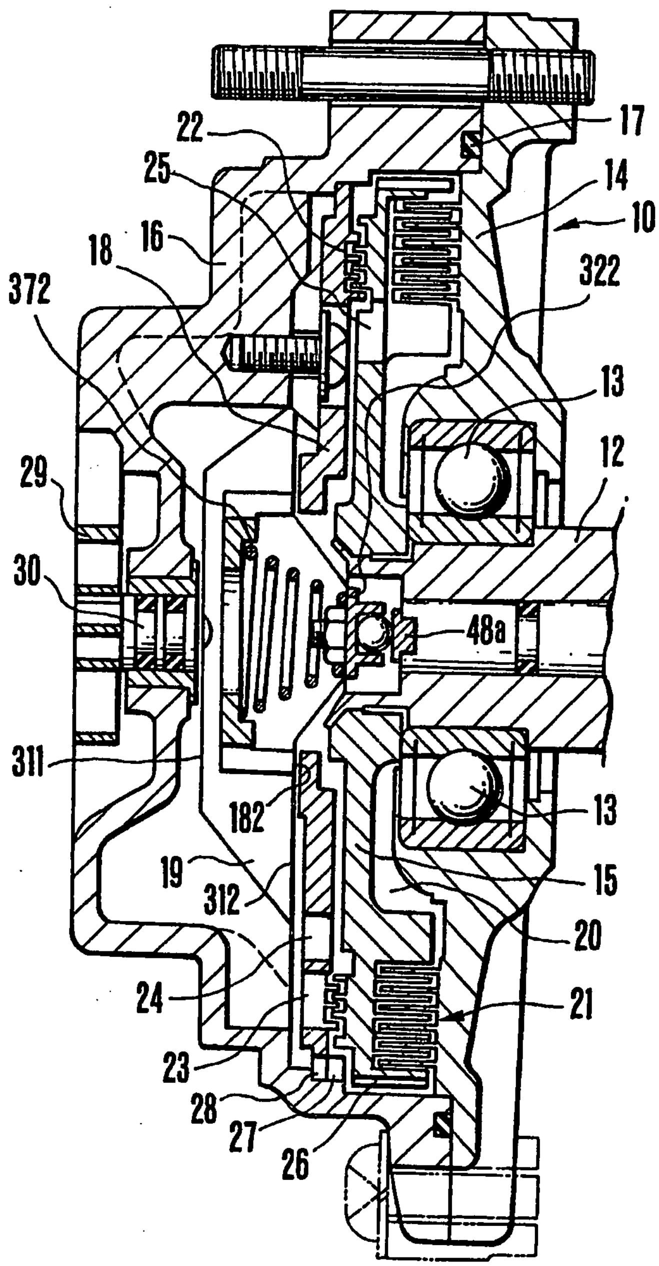
FIG.5



SPECIFICATION

Viscous fluid couplings

The invention relates to viscous fluid couplings which are temperature sensitive and suitable for controlling the transmission of torque to a cooling fan of an automobile engine.

Such couplings are the subject of our earlier Patent Specifications GB 2033061, 2036266, 2044894, 2079414 and 2087049. These couplings detect the temperature of the air around the coupling or passing through the radiator by a bimetal spiral, and generally control the rotational speed of the fan through three stages: OFF, MIDDLE and ON. However, the fan sometimes rotates at high speed even when the temperature of the engine cooling water is low. When the temperature in the engine space is high, and the fan rotates at a high speed (ON) because the volume of air passing through the radiator is small, the air velocity is low, and the air pressure on the bimetal is weak, although the temperature of the air passing through the radiator is low and the temperature of the water in the engine cooling system (corresponding to the OFF or MIDDLE stage) is low, for example when the vehicle is running in a town.

The invention provides a viscous fluid coupling comprising a rotor having a torque transmitting labyrinth in an operating chamber, the amount of fluid in the chamber being controlled by a partition separating the operating chamber from a reservoir, a thermally responsive valve for increasing fluid return from the reservoir to the operating chamber as the air temperature around the coupling rises, and a thermostat for increasing fluid return as the temperature in the engine cooling system rises. This makes it possible to feed to the engine a volume of air accurately corresponding to the heat generated.

The coupling may comprise a single valve plate which controls the opening and closing of a first and a second return hole in the partition preferably by a rotary movement from the thermally responsive valve and an axial, movement from the thermostat. Alternatively, separate valve plates may be provided for the valve and the thermostat.

The preferred method of operation is as follows: When the temperature is lower than a first specified temperature, the first and second return holes are closed by the valve plate, and the fan rotation is maintained in the OFF state. As the temperature rises to the first specified temperature, the (bimetal) valve detects the temperature of the air passing through the radiator, and actuates the valve plate to move around on the partition, open the first return hole, and maintain the fan rotation in the MIDDLE state. As the temperature rises further to a second specified temperature, the thermostat detects the temperature of the (engine cooling system) water, actuates the valve plate in an axial direction to open the second return hole, and maintains the fan rotation in the ON state. Particularly if the thermostat operates by directly sensing the temperature of the cooling water flowing into a vortex chamber of the water pump, there is no possibility of the fan rotation being turned ON by the atmospheric temperature in the engine space.

Drawings

Figure 1 is a longitudinal section through a viscous fluid coupling in accordance with the invention;

Figure 2 is an enlarged view of a portion *A* of the coupling of Figure 1;

Figure 3 is a cross section on B-B in Figure 2;

Figure 4 is a front view of a partition in Figure 1;

Figure 5 is a partial longitudinal section through another coupling in accordance with the invention; and

Figure 6 is a front view of a partition in Figure 5.

Referring to Figure 1, a coupling 10 is provided with rotary shaft 12 as an input member. This receives drive from an engine (not shown) through a pulley 11, a casing 14 freely rotatably supported on the shaft 12 through a bearing 13, and a rotor 15 integrally connected to the left hand end of the shaft 12. A cover 16 carrying an engine cooling fan (not shown) is fixed on the casing 14 through an O-ring seal 17. A space between the casing 14 and cover 16 is separated into a reservoir 19 for viscous fluid and a working chamber 20 which accommodates the rotor 15. On the opposing surfaces of the rotor 15 and casing 14 is a first torque transmitting surface 21 comprising labyrinth grooves. On the opposing surfaces of the rotor 15 and a partition 18 fast in the cover 16 is a second torque transmitting surface 22 comprising labyrinth grooves. In the partition times 18 a first return hole 23 is formed near an outer periphery in the radial direction, and a second return hole 24 is formed nearer the inner centre as a passageway for the fluid from the reservoir 19 to the working chamber 20. A passageway 25 is formed in the rotor 15 so that fluid can be fed to the first torque transmitting surface 21 through the second return hole 24. A pump mechanism is formed by a notch 26 on the outer periphery of the rotor 15, a pump projection 27 on the outer periphery of the partition plate 18, and a pump hole 28. When relative rotation occurs between the rotor 15 and the partition 18, the fluid in chamber 20 is fed to the reservoir chamber 19 by the action of the pump.

A bimetal spiral 29 for detecting the temperature of the air passing through the radiator is mounted on the front of the cover 16. The outer end of the bimetal 29 is fixed to the cover 16, whereas the inner end is fixed to a rod 30 rotatably mounted on the cover 16.

A valve plate 31 disposed to the right of the reservoir 19 is fixed between a valve shaft 32 and a guide 33 connected to the shaft 32 by a screw at its centre. A leftward projection of the guide 33 fits into a groove formed in a rightward projection 30a of the rod 30. Thus the guide 33 rotates integrally with valve plate 31. A guide projection 33a fits into a groove 34 in the rod 30 as the rod 30 rotates. The valve plate 31 moves around on partition plate 18 interlocked with the bimetal 29, and controls the opening and closing of the first return hole 23. A

stop 35 (Figure 4) restricts the rotation of the valve plate 31, and inhibits rotation at low temperature. A stop 36 inhibits rotation at high temperature. The valve plate 31 is forced in the direction of closing the second return hole 24 at all times by a spring 37 of which an end is fixed to the flange 30b of the rod 30. The projection 33a is movable in the axial direction in the groove 34. The valve plate 31 is shifted in the axial direction by a thermostat and controls the opening and closing of the second return hole 24.

A water pump 38 for circulating cooling water for the engine has a pump body 39 fixed to a stationary section of the engine, and a rotary shaft 40 therein. The shaft 40 is integral with the shaft 12 of the coupling 10, and is subject to drive from the engine in the same manner. The engine cooling water flows from the radiator into a vortex chamber 43 in the body 39, and is fed to a delivery passageway 44 by an impeller 42 of a pump rotor 41 fixed on the shaft 40. The cooling water is sealed in the vortex chamber 43 by a mechanical seal 45. A thermostat 46 which detects the temperature of the cooling water in the vortex chamber 43 is installed at the right hand end of the shaft 40. A first rod 47 interlocked with the thermostat 46 is disposed in a through-hole 40b in the shaft 40 and movable in the axial direction. A second rod 48 connected to the first rod 47 is accommodated in the shaft 12 and movable in the axial direction. A ball 49 accommodated in the valve shaft 32 contacts a rod 48.

Operation

The valve plate 31 closes the return holes 23, 24 as shown in Figure 4 when the temperature of the air passing through the radiator is lower than a first specified temperature T1, the volume of the fluid in the working chamber 20 is a minimum, and the rotation of the fan on the cover 16 is maintained at a low speed (OFF). When the temperature of the air passing through the radiator reaches the first specified temperature T1 as the temperature rises, the valve plate 31 opens the first return hole 23, fluid is fed from the reservoir 19 to the second torque transmitting surface 22 through the first return hole 23, and fan rotation is maintained at a medium speed (MIDDLE). When the temperature of the cooling water in the vortex chamber 43 reaches a second specified temperature T2 (where T1 > T2) as the temperature rises further, the thermostat 46 detects the cooling water temperature, elongates in the axial direction, and moves the first rod 47 leftward. The second rod 48, which is connected to the first rod 47 moves leftward, and moves the valve plate 31 in the axial direction against the force of the spring 37. That is to say, the valve plate 31 moves away from the partition 18, and opens the second return hole 24. Fluid is fed from the reservoir 19 to the first torque transmitting surface 21 through the passageway 25, and the fan is maintained at a high speed (ON).

Modification

The coupling shown in Figure 5 is provided with two valve plates, a first valve plate 311 for opening and closing the first return hole 23, and a second valve plate 312 for opening and closing the second return hole 24. The first valve plate 311 is fixed to the rod 30 and rotates on the partition 18. A stop 352 (Figure 6) restricts the rotation of the first valve plate 311. The second valve plate 312 on the partition 18 moves in the axial direction and is fixed to a valve shaft 322 at its centre. The second valve plate 312 is always biased by a spring 372 supported by the partition 18 to close the second return hole 24, and contacts a raised portion of the partition 18.

Operation

The first valve plate 311 closes the first return hole 23. The second valve plate 312 closes the second return hole 24 as shown in Figure 6 when the temperature of the air passing through the radiator is lower than the first specified temperature T1, the volume of the fluid in the working chamber 20 is a minimum and the rotation of the fan is maintained at a low speed (OFF). When the temperature of the air passing through the radiator reaches the first specified temperature T1 as the temperature rises, the first valve plate 311 opens the first return hole 23, fluid is fed from the reservoir 19 to the second torque transmitting surface 22 through the first return hole 23, and the fan rotation is maintained at a medium speed (MIDDLE). When the temperature of the cooling water in the vortex chamber 43 (as in Figure 1) reaches the second specified temperature T2 (where T1 > T2) the thermostat 46 detects the cooling water temperature and elongates in the axial direction to move the first rod 47 leftward. The second rod 48 moves leftward, and moves the second valve plate 33 in the axial direction against the force of the spring 372. The second valve plate 312 moves away from the partition 18 to open the second return hole 24. Fluid is fed from the reservoir 19 to the first torque transmitting surface 21 through the passageway 25, and the fan is maintained at a high speed (ON).

Since the temperature of the cooling water for the engine is directly detected to control the changeover of the fan from medium to high speed (from MIDDLE to ON), the required volume of air can be accurately fed depending on the heat generated by the engine. The bimetal spiral detects the first specified temperature, and the thermostat detects the second specified temperature, so it is easy to set these temperatures, operational reliability is good.

CLAIMS

1. A viscous fluid coupling comprising a rotor having a torque transmitting labyrinth in an operating chamber, the amount of fluid in the chamber being controlled by a partition separating the operating chamber from a reservoir, a thermally responsive valve for increasing fluid return from the reservoir to the operating chamber as the air temperature around the coupling rises, and a thermostat for increasing fluid return as the temperature

in the engine cooling system rises.

2. A coupling according to claim 1 in which the partition comprises a first return hole closed by the thermally responsive valve and a second return hole closed by the thermostat.

3. A coupling according to claim 1 or claim 2 which comprises a single valve plate actuated by both the thermally responsive valve and the thermostat.

4. A coupling according to claim 1 or claim 2 which comprises a separate valve plate actuated by each of the thermally responsive valve and the thermostat.

5. A viscous fluid coupling as herein described with reference to Figures 1 to 4 of the drawings.

6. A viscous fluid coupling according to claim 5 as modified by Figures 5 and 6 of the drawings.

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